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Comparative Analysis of Laparoscopy Versus Laparotomy for Managing Adhesive Bowel Obstruction in Pediatric Patients: A Systematic Review and Meta-Analysis

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Abstract **Objectives:** We found that the analyzed studies reported a significant difference in hospital length of stay between patients undergoing laparoscopy and those undergoing laparotomy. Postoperative complications were significantly lower with laparoscopy than with laparotomy. This systematic review critically evaluates the existing literature comparing laparoscopy and laparotomy as surgical approaches for managing adhesive bowel obstruction in pediatric patients, aiming to guide clinicians in evidence-based care. **Methods:** This systematic review was conducted in adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The search focused on identifying studies that compared the outcomes of laparoscopic and open laparotomy procedures in pediatric patients (<18 years old) with ileus, bowel obstruction, or adhesive small bowel obstruction (ASBO), using the PubMed and Google Scholar databases. Data on each study's origin, design, sample size, mean age at presentation, treatment modality, specific intervention(s), and key outcomes were extracted. The studies were then grouped into two categories (laparoscopy and laparotomy), followed by a descriptive analysis. **Results:** Our search identified three retrospective cohort studies that met the inclusion criteria and were selected for meta-analysis. This highlights the limited availability of high-quality evidence, as the findings rely solely on retrospective cohort studies. **Conclusion:** The study highlights the benefits and differences between laparoscopy and laparotomy in treating adhesive small bowel obstruction in children. Laparoscopy was found to be associated with fewer postoperative complications. Further research may strengthen these findings and explore the long-term outcomes of this treatment strategy.

Key Words Pediatric Adhesive obstruction, laparoscopy, laparotomy

INTRODUCTION

Adhesive small bowel obstruction (ASBO) is described as a small intestinal obstruction caused by traumatic or congenital scar tissue formed between two unconnected organs, loops, or walls. ASBO represents around 51% of all cases of acute abdomen, making it one of the most common emergencies. The adhesions from abdominal surgery were the cause of almost 60% of ASBO cases [1].

The primary factors used to make the diagnosis are the patient's history of abdominal surgery, clinical symptoms (vomiting and nausea, abdominal distention and pain, lack of recent flatus or stool), and radiologic findings (small bowel or colonic distention with air fluid levels, and/or transition point on axial imaging) [2].

A major risk factor for ASBO is the type of surgery performed and the degree of peritoneal injury. Surgery on

the lower abdomen and pelvis carries a larger risk of adhesion formation than surgery on the upper abdomen. The studies showed that the first presentation might happen from one month to five years after surgery for 20% of cases, 30% in a year, 25% in the succeeding one to five years, and 25% in five to twenty-five years. As well, the first ASBO operation often occurs 0.9 to 1.4 years following colorectal surgery, 1.8 years following hepatobiliary surgery, 2 years following an appendectomy, 4 years following gastric surgery, and 7 years following gynecological surgery [3].

Moreover, a significant harm is caused by ASBO, which results in an average hospital stay of 8 days and a 3%mortality rate in the hospital. Hospital stay length and morbidity are both affected by the need for surgical intervention [4]. Besides that, the socioeconomic costs associated with ASBO increased significantly, and a significant amount of money and resources are spent on treating adhesion-related diseases. For example, the estimated cost of direct patient care in the US in 1994 due to adhesion-related illnesses was US$1.3 billion. Thus, the financial burden of adhesions will continue to expand as long as health care costs keep rising and the number of patients needing surgery increases [3].

Despite being a common condition, the prevention and treatment of adhesive small bowel obstructions are often determined by surgeons' personal preferences rather than standardized evidence-based protocols. A large amount of conflicting and low-quality evidence exists regarding adhesive small bowel obstruction treatment [4].

In children, the management of ASBO hasn't been extensively studied in the past. Although the use of the laparoscopic approach has increased in the management of adult ASBO, there is still a lack of comparative data from children's populations. So, the statistical ability to make definitive decisions is inadequate. A systematic review conducted by Smith *et al.* in 2018 revealed a lack of high-quality data comparing open versus laparoscopic procedures on children with ASBO. Additionally, a study done by Hernandez-Martin *et al.* in 2020 suggested for bigger, multi-center investigations to support their findings after reporting encouraging outcomes with laparoscopy in a retrospective study of 45 pediatric cases [5].

Moreover, A study performed at Wilhelmina Children's University Hospital revealed that, 9 children had laparoscopies; 6 of them their recovery went well. However, 2 patients had an elective laparotomy due to severe malignant adhesions. During the same time, 11 children underwent laparotomies, 5 of them had obstructing and would have benefited from a laparoscopic approach. It proves that laparoscopic management of ASBO is rewarding [6].

Also, a meta-analysis and systematic review reveal that, when compared to laparotomy, laparoscopy is associated with a lower incidence of complications in children with ASBO. However, the quality of the evidence is relatively low, and there is a substantial risk of confounding bias [5]. Thus, we aim in this study to compare laparoscopy and laparotomy as surgical approaches for managing adhesive bowel obstruction in pediatric patients, by assessing the incidence of intraoperative and postoperative complications associated with each surgical method, as well as evaluating the length of hospital stay.

METHODS

Literature Search Strategy

It was conducted in adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive electronic search was conducted in the PubMed and Google Scholar databases for studies published in 1999, 2001, 2023, and 2024. The search strategy was designed independently by one of the authors (K.H.) and approved by the rest of the study team.

An amalgamation of Medical Subject Headings (MeSH) such as "Pediatric" or "Children," "Laparoscopy" or "Laparoscope," "Ileus" or "Bowel Obstruction" or "Adhesive Small Bowel Obstruction" or "ASBO," and "Laparotomy," was used to inclusively identify all studies comparing laparoscopy and laparotomy outcomes in the paediatric population. References of the selected studies were further reviewed to identify any missing articles. The full search strategy can be found in the supplemental information (Figure 1).

Inclusion/Exclusion Criteria

This review included all clinical studies that provided information on pediatric patients (<18 years old) being treated for bowel obstruction, regardless of the treatment modality, and that were published in English. Studies were required to report both functional and aesthetic patient outcomes, as both considerations play a substantial role in determining the degree of treatment success for bowel obstruction. There were no restrictions on the type of study design. Exclusion criteria included the following: case reports, abstracts, conference proceedings, studies primarily focusing on conditions other than bowel obstruction, and studies that did not clearly report functional and aesthetic outcomes

Selection of Articles and Data Extraction

The deduplicated results were subsequently imported into Rayyan and screened by four authors (K.H., B.A., W.F., L.A.) for relevance based on the title and abstract. The full texts of all retained studies were then independently screened by the same four authors for final inclusion or exclusion. Disagreements at any stage of the screening process were resolved through discussion and consensus among all authors. Data extracted from the retained studies included the year of publication, country of origin, study design, sample size, study period, mean age at the time of presentation, treatment modality, contraindications, length of hospital stay, total hospital cost, return of bowel function (days), comorbidities, advantages, and key outcomes (both functional and aesthetic). For our data analysis, studies were categorized based on treatment approach into either laparoscopy or laparotomy.

Assessment of the Risk of Bias of the Included Studies

Methods

The Cochrane risk tool for bias was used to evaluate the quality of RCTs. This tool has various domains, and the judgments within each domain were carried forward for an overall RoB2 judgment across five main domains. These domains are fixed, focusing on aspects of trial design, conduct, and reporting using a series of 'signalling questions' to elicit information relevant to the risk of bias. This is then judged using an algorithm, and the judgments can be 'low' (for all domains, the risk of bias is low), can express 'some concerns' (for at least one of the domains, there is some concern) or 'high' (for at least one domain has a high risk or some concerns for multiple domains). The risk of bias assessment was conducted independently by two authors (Khalid, Baraa), and disagreements were resolved with consensus after consultation with senior authors (Manar Almaliki). We evaluated all the articles included in the review according to the American Society of Pediatric Surgery.

RESULTS

The bias risk was assessed by two reviewers simultaneously and separately. Two reviewers independently assessed the risk of bias for eligible RCTs using the Cochrane Risk of Bias Assessment Tool for Randomized Trials (RoB 2). Using the Revised Cochrane tool (Table 1) In the Revised Cochrane tool, three of the included RCTs were considered to have some concerns of bias, and only one was considered high risk. According to the level of evidence and grading recommendations of the American Society of Pediatric Surgery.

Risk of Bias of the Result

The quality of the included studies was assessed using the Cochrane risk-of-bias tool (RoB-2). It is a recently introduced assessment tool to analyze bias in a trial. This includes assessment at five stages or domains. These domains include the presence of bias due to the randomizations process, deviations from the intended interventions, missing outcome data, measurement of the outcome and due to selection of the reported result. Bias, if present in each domain, was categorized as either "low risk of bias," "some concerns," or "high risk of bias." Studies with all five domains at low risk of bias were considered as low risk of bias. A study was considered to have high risk of bias even if one domain was at high risk of bias or multiple domains had some concerns. Studies were considered as "some concern" if any domain had this result but not at high risk for any domain. The eligible trials were assessed for bias by two authors (Baraa and Khalid) independently, and any disagreements were resolved after consultation with the third author (Manar).

Statistical analysis

The pooled analysis was performed by Review Manager 5.4 software (Review Manager (RevMan). Version 5.4. The Cochrane Collaboration, 2020). For dichotomous variables, risk ratio (RR) was calculated for individual studies and the pooled RR was calculated using the Mantel-Haenszel (M-H) method. For continuous variables, mean difference (MD) was computed for each individual study and the weighted mean difference for pooled analysis using the inverse variance method. All statistical variables were calculated with a 95% confidence interval (95% CI). The I2 test was used to analyse heterogeneity of trials. When I2 was greater than 50%, it was considered as heterogeneous, and the M-H or inverse variance random-effects model was used. If I2 was less than 50%, the data were considered homogenous and the fixed-effects model was used. Sensitivity analysis was done after excluding studies considered to be at high risk of bias for the particular outcome. p value of <0.05 was considered to be significant.

Results

We identified 880 articles after removing duplicates. 850 articles were excluded during title and abstract screening. Full-text screening was performed, and there was no RCT. Three retrospective cohort studies were selected for meta-analysis (Figure 1).

As no RCT was found, the meta-analysis was performed only for observational studies. The characteristics of included studies are shown in (Table 2). Of the three included studies, two were single-centre cohorts and one was a multicentre cohort study. In two studies, mean age was significantly higher in the laparoscopy group compared to the laparotomy [5,7]. In the other study [8], mean age at surgery was reported but differences between study group were not statistically analyzed. In the laparoscopy group, the conversion rate to laparotomy ranged from 10.3 to 17% (Table 2).

Table 1: Review authors' judgments about each risk of bias item for each included study

References	Bias arising from the randomization process	Bias due to deviations from intended interventions	Bias due to missing outcome data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall RoB
van der Zee *et al.* [6]	High	Low	Low	Low	Low	Some concerns
Rafik *et al.*	Low	Not clear	High	Low	Low	Some concerns
Fu *et al.* [1]	High	Low	Low	Low	Low	High
Patwardhan *et al.* [5]	High	Not clear	Low	Low	Low	Some concerns

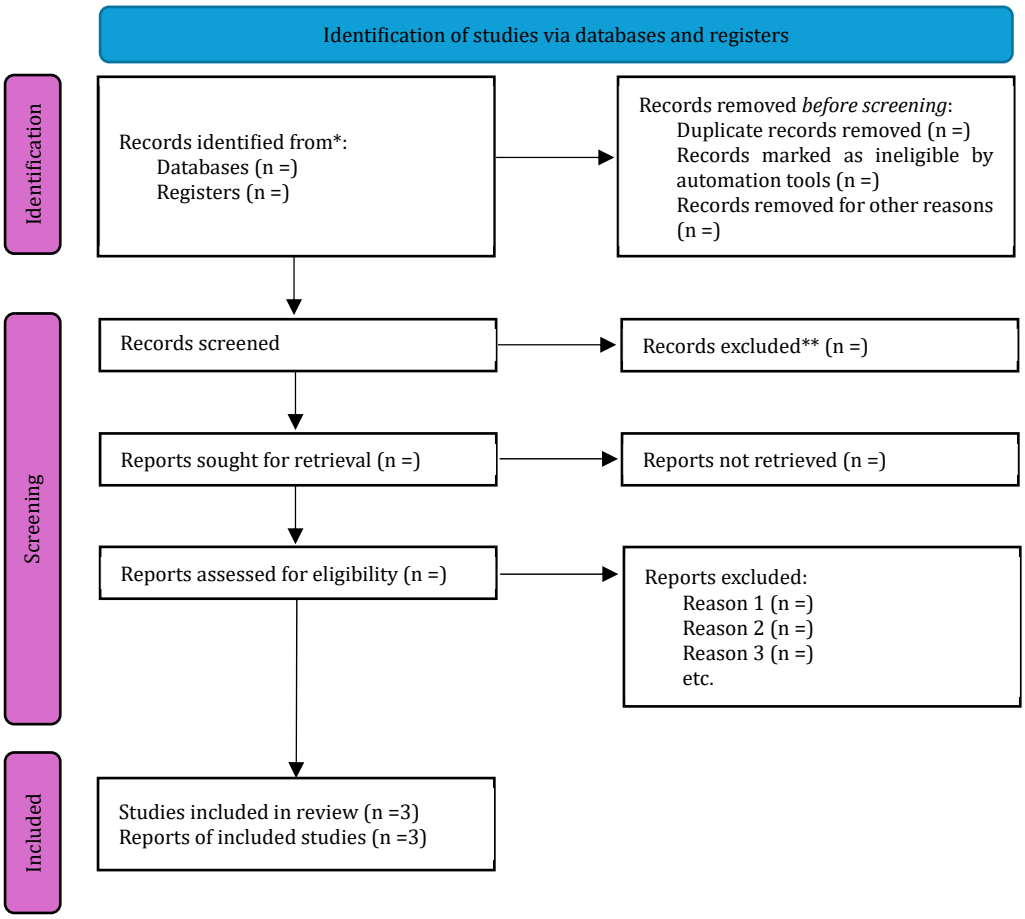
Identification of studies via databases and registers
Identification
Records identified from*:
Databases (n =)
Registers (n =)
Records removed *before screening*:
Duplicate records removed (n =)
Records marked as ineligible by automation tools (n =)
Records removed for other reasons (n =)
Screening
Records screened
Records excluded** (n =)
Reports sought for retrieval (n =)
Reports not retrieved (n =)
Reports assessed for eligibility (n =)
Reports excluded:
Reason 1 (n =)
Reason 2 (n =)
Reason 3 (n =)
etc.
Included
Studies included in review (n =3)
Reports of included studies (n =3)

Figure 1: PRISMA flow diagram of searching process and screening

Laparoscopy
Laparotomy
Risk Ratio
Risk Ratio
Study or Subgroup Events Total Events Total Weight M-H, Random, 95% CI Year
M-H, Random, 95% CI
Lee et al 2012 63 1126 906 8736 46.3% 0.54 [0.42, 0.69] 2012
Kumar et al 2019 0 26 20 42 3.1% 0.04 [0.00, 0.62] 2019
Patwardhan et al 2024 107 164 331 381 50.6% 0.75 [0.67, 0.85] 2024
Total (95% CI) 1316 9159 100.0% 0.59 [0.35, 0.97]
Total events 170 1257
Heterogeneity: Tau² = 0.13; Chi² = 15.07, df = 2 (P = 0.0005); I² = 87%
Test for overall effect: Z = 2.07 (P = 0.04)
0.005 0.1 1 10 200
Laparoscopy Laparotomy

Figure 2: Forest plot of complications after laparoscopy versus laparotomy

Table 2: Characteristics of included studies in the meta-analysis

Study ID	Study design	Country	Years of the study	Population	Sample size	Conversion to laparotomy during laparoscopy
Lee *et al.* [7]	Retrospective cohort	Boston, Massachusetts	1997, 2000, 2003, 2006, 2009	Pediatric adhesive bowel obstruction cases	Laparoscopy 1126 Laparotomy 8736	17% (191/1126)
Kumar *et al.* [8]	Retrospective	Kuwait	2007 to 2017	Children with adhesive bowel obstruction were managed at a tertiary care level center for pediatric surgery	Laparoscopy 26 Laparotomy 42	10.3% (4/30)
Patwardhan *et al.* [5]	Retrospective cohort	USA	2007-2020	Pediatric patients (<18 years of age) that were admitted with ASBO	Laparoscopy 164 Laparotomy 381	10.3% (4/30)

Table 3: Risk of bias assessment using ROBINS-2

Domain	Lee *et al.* [7]	Kumar *et al.* [8]	Patwardhan *et al.* [5]
Bias arising from the randomization process	High	High	High
Bias due to deviations from intended interventions	Low	Low	Not clear
Bias due to missing outcome data	Low	Low	Low
Bias in measurement of the outcome	Low	Low	Low
Bias in selection of the reported result	Low	Low	Low
Overall	High	High	Some concerns

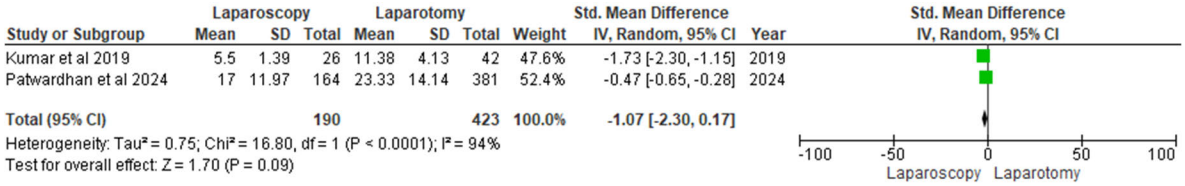
Laparoscopy
Laparotomy
Std. Mean Difference
Std. Mean Difference
Study or Subgroup Mean SD Total Mean SD Total Weight IV, Random, 95% CI Year
IV, Random, 95% CI
Kumar et al 2019 5.5 1.39 26 11.38 4.13 42 47.6% -1.73 [-2.30, -1.15] 2019
Patwardhan et al 2024 17 11.97 164 23.33 14.14 381 52.4% -0.47 [-0.65, -0.28] 2024
Total (95% CI) 190 423 100.0% -1.07 [-2.30, 0.17]
Heterogeneity: Tau² = 0.75; Chi² = 16.80, df = 1 (P < 0.0001); I² = 94%
Test for overall effect: Z = 1.70 (P = 0.09)
-100
-50
0
50
100
Laparoscopy
Laparotomy

Figure 3: Forest plot of hospital LOS in laparoscopy versus laparotomy

Clinical Outcomes

Postoperative Complications: Postoperative complications were significantly decreased in laparoscopy (12.91%, 170/1316) than laparotomy (13.72%, 1257/9159) with (RR 0.59; 95% CI, 0.35–0.97) (Figure 2).

Length of postoperative hospital stay (days)

There was no significant difference in hospital LOS between the laparoscopy and laparotomy (MD, −1.07; 95% CI, −2.30 to 0.17, I2 = 94%) (Figure 3).

Postoperative 30-day Mortality

The mortality was only reported in the study done by Patwardhan *et al.* [5] which reported that the incidence of mortality was 3 (0.8%) in laparotomy.

Patients Satisfaction

The patient's satisfaction was not reported in any study.

Risk of bias

The bias risk was assessed by two reviewers simultaneously and separately. Two reviewers independently assessed the risk of bias for eligible RCTs using the Cochrane Risk of Bias Assessment Tool for Randomized Trials (RoB 2). Using the Revised Cochrane tool. In the Revised Cochrane tool, one of the included studies were considered some concerns of bias, and two was considered high risk. According to the level of evidence and grading recommendations of the American Society of Pediatric Surgery (Table 3).

DISCUSSION

The use of laparoscopy versus laparotomy in children with adhesive small bowel obstruction (ASBO) is thoroughly compared in this systematic review and meta-analysis. We found a significant difference in hospital length of stay between patients undergoing laparoscopy and those undergoing laparotomy. This aligns with the findings of a study by Nguyen and Holland [9]. Postoperative complications were significantly lower with laparoscopy than with laparotomy, as it was in previous studies [10]. These studies were selected for comparison because they pertain to the same topic as our research.

ASBO refers to a condition where the small intestine becomes blocked due to adhesions, which are bands of fibrous tissue that can form after abdominal surgery, inflammation, or injury, causing the intestines to stick together or to other organs. We analyzed studies comparing the two procedures used to treat ASBO. The first procedure, laparotomy, is an open surgery of the abdomen, while laparoscopic surgery, often called keyhole surgery, involves two to four small incisions in the abdominal or pelvic area. A surgeon uses flexible tubes to insert a lighted video camera and special tools into the body.

The analyzed studies showed that the hospital stay of patients after laparoscopy is significantly shorter than that of patients after laparotomy. It also indicated that laparoscopy was better for the return of bowel function. There was an incidence of ventral hernia in patients who underwent laparotomy, as well as incidences of venous thromboembolism (VTE), surgical site infection, pneumonia, postoperative shock, and death.

While both laparotomy and laparoscopy have common complications, their incidence varies significantly; for instance, paralytic ileus occurred less frequently in laparoscopic patients than in those who underwent laparotomy, along with lower rates of urinary tract infection (UTI), sepsis, bowel perforation, postoperative malabsorption, bowel resection, and anastomotic stricture. Interestingly, some studies referenced complications of laparoscopic surgery without comparing them to laparotomy, such as respiratory failure, hemorrhage, hematoma, intra-abdominal abscess, anastomotic leak, and seroma. The analyzed studies also reported on the incidence of conversion to laparotomy during laparoscopic procedures. Finally, we believe that many complications were not mentioned in the analyzed studies.

Additionally, the studies showed that the rate of total parenteral nutrition use was lower in patients who underwent laparoscopy, as was the total hospital cost.

Limitations

One limitation of this review is the variability in study designs and sample sizes, which may affect the reliability of the results. Additionally, the lack of long-term follow-up data in many studies limits our understanding of the long-term outcomes and complications associated with both surgical approaches. Furthermore, potential publication bias may skew the findings, as studies with negative results are less likely to be published.

Recommendations

Future research should focus on conducting large-scale, multi-center randomized controlled trials to validate the findings of this review. These studies should include long-term follow-up to assess the durability of outcomes and

complications associated with both laparoscopic and open surgical techniques. Additionally, standardized reporting of complications will enhance comparability between studies. It is also recommended to explore the cost-effectiveness of laparoscopic surgery in a broader range of pediatric populations and to investigate the role of advanced imaging techniques in preoperative planning to optimize patient selection

CONCLUSION

This study investigated the benefits and differences between laparotomy and laparoscopy in treating adhesive small bowel obstruction in children. We found that postoperative complications were fewer in cases of laparoscopic procedures, hospital stay was shorter, and bowel function returned earlier. It is advised that follow-up research be done to determine the prevalence of adhesion-related disorders, the rates at which intestinal obstruction reappear, and the general quality of life outcomes for patients having laparoscopic as opposed to open procedures.

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